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US macroeconomic shocks and international business cycle

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Abstract: This paper estimates the role of six shocks originating in the United States in driving the international business cycle. To this end, it employs impulse response functions and forecast error variance decomposition from panel local projections. We find that key macroeconomic shocks originating in the United States contribute significantly to business cycle synchronization between the US and other economies. These shocks also account for a substantial part of output fluctuations in these economies. Considering individual shock contributions, we document that technology and monetary policy innovations are of the highest relevance.

Keywords: Macroeconomic shocks, International spillovers, International business cycles, Technology shocks, Monetary policy, Financial shocks, Fiscal policy, Investment shocks

JEL codes: E23, E32, E52, E62, F44

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1 Introduction

US business cycles have been recognized as an important driver of fluctuations in global economic activity for a long time. In this context, many studies focused on spillovers of individual shocks originating in the US, such as exogenous shifts in technology, financial variables, investment, monetary, and fiscal policy shocks documenting their substantial international effects. Despite these findings and the fact that these shocks were also shown to be important drivers of the US economy by Ramey (2016), there is no empirical evidence of their impact on other economies within a unified framework.

This paper aims to fill this gap by providing results on the international impact of the main US macroeconomic shocks using a large sample of countries. To this end, we first estimate individual US shocks using the state-of-the-art method for each shock whenever up-to-date time series of the shock are unavailable. Next, we run a set of local projections, both for the US and for the panel of twenty-one open economies. We find that US shocks jointly explain a substantial portion of international business-cycle fluctuations. Among individual shocks, technology and monetary policy shocks emerge as relatively most influential in explaining GDP fluctuations across countries. They are followed by the financial and marginal efficiency of investment shocks, while fiscal policy and investment-specific technology news are the least impactful.

Our study is related to the literature on the international spillovers of US shocks, see e.g.: Canova (2005); Carrillo, Elizondo, and Hernández-Román (2020); Cesa-Bianchi and Sokol (2022); Dedola, Rivolta, and Stracca (2017); Eickmeier and Ng (2015); Helbling, Huidrom, Kose, and Otrok (2011); Kim (2001); Kollmann (2013); Levchenko and Pandalai-Nayar (2020); Maćkowiak (2007); Mumtaz, Simonelli, and Surico (2011); Uribe and Yue (2006); Vicondoa (2019). We contribute to this research by investigating the impact of external shocks collectively within a unified framework. Hence, we extend the study of Ramey (2016) from a domestic to an international context. According to her findings based on the VAR model, only seven US shocks (three fiscal, three technology, and one monetary policy) contribute to 63%–79% of the output and hours variances in the business cycle horizons. Since external shocks are well-identified, using them should improve the precision of estimated spillovers. This in principle could also be the case for estimated dynamic stochastic general equilibrium frameworks in which many structural shocks may be imposed simultaneously, but these models fail to explain cross-country comovement of business cycles, see e.g. Justiniano and Preston (2010); Olivero (2010).

We also build on articles that estimate the total impact of US shocks on other countries in VAR models. For example Justiniano and Preston (2010) order US shocks first in Cholesky decomposition and calculate their total impact on the Canadian economy. Our contribution in this respect lies in investigating the role of well-identified, specific shocks as compared to undefined sources of the total US business cycle fluctuations. Therefore, we provide new insights on key drivers of business cycles in the US and other countries, as well as sources of synchronization between them. However, using various frameworks to estimate US shocks poses a risk of their high correlation. We verify this possibility and find no or little comovement across shock series (Table 1).

Finally, as many studies focus on international spillovers to relatively narrow groups of countries with strong links to the US, see e.g.: Canova (2005); Carrillo et al. (2020); Fink and Schüler (2015); Justiniano and Preston (2010); Levchenko and Pandalai-Nayar (2020), we extend the literature by considering a broad impact of US shocks to a wide set of economies.

The rest of the paper is structured as follows. Section 2 describes the modeling framework and data we use, section 3 – the results of the study. Section 4 concludes.

2 Empirical strategy and data

Our empirical strategy consists of three steps. First, we obtain six US shocks: technology, financial, marginal efficiency of investments, investment-specific technology news, monetary, and fiscal policy. Second, we estimate a local projection model for the US to validate the domestic impact of these shocks. Third, we conduct local panel projection regressions to explore their international transmission. Local projection results are investigated through the lens of impulse response functions (IRFs) and forecast error variance decompositions (FEVDs).

2.1 Estimation of US shocks

As already mentioned, the choice of individual methods for estimating shocks is based on Ramey (2016). However, for two of them, monetary and fiscal policies, we did not have access to the necessary data sets, so we substituted them with up-to-date alternatives from the literature. We verified that estimates of the shocks updated by us closely mimic their predecessors in the literature (results available upon request).

We choose shocks that describe a wide range of drivers of the US business cycle. Starting with technology, we follow Francis, Owyang, Roush, and DiCecio (2014), who identify the neutral technology shock as the one that maximizes the share in the FEVD of labor productivity at the finite long-term horizon. The underlying assumption of this approach is that the technology shock drives long-term shifts in labor productivity, while other structural innovations have transitory effects.

Next, we apply the method of Gilchrist and Zakrajšek (2012) to retrieve financial shocks to the excess bond premium (EBP) that are identified as orthogonal to the current state of the economy. EBP itself, in turn, is estimated as the residual part of credit spread that can not be explained by firm-specific information on expected defaults.

Moving to investment shocks, we consider their two types. The first affects the marginal efficiency of investment (MEI) as in Justiniano, Primiceri, and Tambalotti (2011) and acts as a proxy of the effectiveness with which the financial sector channels the flow of household savings into new productive capital. The second shock is an investment-specific technology (IST) news shock proposed by Ben Zeev and Khan (2015). It is identified as the one that contributes the most to IST over 15 years and is orthogonal to current IST and total factor productivity.

For the US monetary shock, we employ high-frequency estimates following Nakamura and Steinsson (2018) calculated as the first principal component of unexpected changes in interest rates in a 30-minute window surrounding Federal Reserve announcements. Finally, the fiscal policy shock is based on the approach of Forni and Gambetti (2016). They use the Survey of Professional Forecasters (SPF) which allows us to retrieve expectations of future spending growth and their news shock component orthogonal to factors normally affecting fiscal policy.

2.2 Local projection

In order to obtain IRFs to US shocks, we estimate two local projection models. First, we verify the effects of US shocks on the US business cycle with the set of following regressions for each k-th shock:

$$y_{t+h} - y_{t-1} = \alpha_h + \varepsilon_t^k \beta_h + \mathbf{x}_t \gamma_h + \nu_{t+h} \tag{1}$$

where $h = 0, ..., 20$ denotes horizons, t – quarterly time periods, y_t – the US GDP in period t, ε_t^k – one of six US shocks, $\mathbf{x}_t$ – vector of control variables, γ_h – vector of parameters, ν_{t+h} – residuals in local projection for the horizon h, while $\beta_\mathbf{h}$ and γ_h are estimated parameters. The list of control variables consists of four lags of: dependent variable, GDP growth in OECD countries and VXO index.

Second, in order to analyze the international spillovers of US shocks we estimate a set of panel local projections with country-fixed effects:

$$y_{j,t+h} - y_{j,t-1} = \alpha_{j,h} + \varepsilon_t^k \beta_h + \mathbf{x}_{j,t} \gamma_h + \nu_{j,t+h} \tag{2}$$

where j indexes countries, $y_{j,t+h}$ is GDP in country j in time t, the vector $\mathbf{x}_{j,t}$ consists of country-specific and global control variables – four lags of: dependent variable, shock ε_t^k, OECD GDP growth, VXO index, CPI inflation, short-term interest rate and exchange rate against the US dollar. Regression residuals are represented by $\nu_{j,t+h}$. While deciding on the set of controls and the number of lags, we followed common practices. GDP growth in OECD countries captures the impact of international business cycle, the VXO index accounts for changes in market sentiment, while domestic lagged variables mop up the lagged effects of domestic business cycles. The choice of four lags, in turn, is related to the quarterly frequency of the data.

2.3 Forecast error variance decomposition in local projections

In order to estimate FEVD we apply Gorodnichenko and Lee (2020) R^2 method both to US and panel local projection regressions with small-sample refinements[1]. As the procedure for the time series is explained in detail in the original paper, in what follows we describe only its application in the panel context.

As the first step, we conduct a within transformation of the data. Second, we run the local projection in eq. 3 and calculate the forecast errors $f_{j,t+h|t-1}$ for the horizon $t+h$ given the information set from period $t-1$:

$$y_{j,t+h} - y_{j,t-1} = \sum_k \sum_{i=1}^{4} \varepsilon_{t-i}^k \beta_\mathbf{i}^\mathbf{h} + \mathbf{x}_{j,t} \gamma_h + f_{j,t+h|t-1} \tag{3}$$

The choice of regressors is likely to affect FEVD results – the more independent variables, the lower variance of the dependent variable unexplained by the regression. Therefore, we consider three specifications. The baseline includes the same controls as used to compute IRFs, with the only difference being the shocks taken together instead of one at a time. In the second, which we call "US controls", we limit the number of regressors by excluding additional country-specific control variables in the panel regression as compared with its US counterpart, i.e. CPI inflation, interest rate and exchange rate. In the third –

[1] We also applied partial R^2 method proposed by Gorodnichenko and Lee (2020) and found very similar results

"core controls" – we keep only lags of dependent variables and lagged shocks in the vector $\mathbf{x}_{j,t}$.

Having obtained forecast errors, in the third step we regress them on shocks in subsequent h periods where $h = 0, 4, ..., 20$. Our main focus is on the total impact of US shocks on GDP fluctuations in SOEs which is given by eq.

$$\hat{f}_{j,t+h|t-1} = \sum_{k} \left(\alpha_h^k \varepsilon_{t+h}^k + \alpha_{h-1}^k \varepsilon_{t+h-1}^k + ... + \alpha_0^k \varepsilon_t^k\right) + \nu_{j,t+h|t-1} \tag{4}$$

However, such an estimate does not reveal the relative importance of shocks. To investigate this issue we additionally focus on individual effects of k-th shock estimating in the second and third step eq. 5 and 6:

$$y_{j,t+h} - y_{j,t-1} = \sum_{i=1}^{4} \varepsilon_{t-i}^k \beta_{\mathbf{i}}^{\mathbf{h}} + \mathbf{x}_{j,t}\gamma_h + f_{j,t+h|t-1} \tag{5}$$

$$\hat{f}_{j,t+h|t-1} = \alpha_h^k \varepsilon_{t+h}^k + \alpha_{h-1}^k \varepsilon_{t+h-1}^k + ... + \alpha_0^k \varepsilon_t^k + \nu_{j,t+h|t-1} \tag{6}$$

Gorodnichenko and Lee (2020) show that R^2 from regressions like eq. 4 and 6 is an asymptotically unbiased estimator of FEVD which, however, is biased in small samples. Therefore, we follow Gorodnichenko and Lee (2020) and conduct a bootstrap estimation. First, we estimate the VAR(1) model using $y_{j,t}$, ε_t^k and $\mathbf{x}_{j,t}$. Next, we generate artificial time series of variables from this VAR. To this end, we simulate the VAR model using estimated parameters, initial values of variables from a randomly chosen period in the dataset and randomly drawn (with replacement) residuals from the reduced VAR. The number of draws is set to 1500 out of which 500 are burnt.

Finally, we estimate the local projection model and calculate the FEVD using the artificial data in first and second step regressions described above. We set the number of simulations to 600 and report the average contributions of shocks to GDP and their standard deviations.

Note that the sum of individual contributions given by eq. 6 is likely to be larger than the total contribution from eq. 3 as there is non-zero correlation between shocks.

2.4 Data

We use several data sources to construct datasets for reproduction of US technology, financial, and investment shocks: Federal Reserve Bank of St. Louis (FRED), U.S. Bureau of Labor Statistics, Catalán and Hoffmaister (2023), Fernald (2014), and Bloomberg. In terms of scope, we compute updated shocks starting from the quarter of when the original shock is computed up to latest available data at the end of 2023. Details of each dataset used for reproduction are presented in Tables 1-3 in Appendix. As for monetary policy and fiscal policy shocks we use time series obtained – respectively – from Acosta (2022) and Turgut and Wesołowski (2025).

In the local projections we use quarterly macroeconomic data retrieved from the OECD and VXO index from FRED (see Table 4 in Appendix) as well as estimated shocks. The dataset consists of 21 open economies: 11 advanced (Australia, Canada, France, Germany, Israel, Japan, South Korea, New Zealand, Norway, Sweden, United Kingdom) and 10 emerging markets (Brazil, Chile, Colombia, Czechia, Hungary, India, Indonesia, Mexico, Poland, Turkey). The dataset spans the period 1982q4-2019q4 for the US and 1995q2-2019q4 for the panel (see Table 5 in Appendix for information on individual countries).

We cut the sample before 2020 to exclude Covid-19-related shocks and country-specific policies related to it.

3 Results

In this section we document two sets of results obtained with local projections as described in section 2.2: IRFs and FEVDs. Figure 1 presents the US GDP responses to US shocks. Although all of them are expansionary, some differences stand out. The maximum GDP increase following a one-standard-deviation shock ranges from 0.1% for MEI to 0.8% for technology innovation. Furthermore, technology and financial shocks are more persistent than the other shocks. On the other hand, after the IST news shock it takes a few quarters for GDP response to become positive and this outcome is barely statistically significant.

The different responses of US GDP to the examined shocks affect spillovers to other economies (Figure 2). Again, technology and financial shocks are the most persistent. On the other hand, international effects of the US monetary policy seem to be somewhat longer-lasting than their domestic counterparts. All in all, based on the IRF analysis we expect these three disturbances to have a relatively large impact on the GDP fluctuations. Furthermore, similar paths of GDP in the US and panel regressions across all innovations combined with relatively strong output spillovers indicate that investigated shocks are important sources of international business cycle synchronization.

In order to assess the scale of the impact of US shocks both domestically and internationally, which is the main focus of this article, Table 2 presents their contributions to the FEVD of GDP. For the US we use the same specification as for the impulse responses, while for the panel data we present three specifications discussed in Section 2.2.

We find that on impact the US shocks explain 36% of GDP forecast error in the US and around 3% in other countries. In next years these contributions are substantially higher. Focusing on the middle horizon in our sample, i.e. three years, we document that six US shocks explain 74% of GDP fluctuations in the US consistently with Ramey (2016) estimates, confirming the high importance of the main US shocks in the output fluctuations in the US. At the same time these shocks contribute to 23-31% of the GDP FEVD in the panel of economies. The bootstrap standard deviations are moderate as compared to mean estimates and the differences across methods – modest and broadly following our intuition – more control variables in the regression usually is accompanied by the higher contribution to the FEVD. Furthermore, as a robustness check, we verify that results do not change much if the number of lags is changed to two (results available upon request). We conclude that six US shocks considered in this study explain a large portion of both US and international business cycle.

Moving to individual shock contributions, we find that technology and monetary policy are of highest relevance in explaining international business cycle fluctuations as their shares in FEVD amount to –respectively – 14% and 15% in three-year horizon, see Table 3. Financial and marginal efficiency of investments innovations contribute less but still substantially (8% and 6%), while fiscal policy and investment-specific technology shocks are less important, with shares of 2%. Interestingly, FEVD estimates point to the substantial impact of MEI shock which might be underappreciated when just focusing on its international effects based on IRF graphs. This notwithstanding, the FEVDs results are in general consistent with IRFs pointing to the importance of international spillovers of US technology, monetary policy and – to a lesser extent – financial and investment shocks.

4 Conclusions

In summary, using estimates of six key US macroeconomic shocks – technology, financial, marginal efficiency of investments, investment-specific technology news, monetary, and fiscal policy – we show within a unified local projection framework that they drive business cycle synchronization between the US and other economies. Furthermore, we document that these shocks explain a substantial portion of international business cycle fluctuations. When comparing individual shares in GDP FEVD in the panel of twenty-one countries, we find relatively high contribution of US technology and monetary policy innovations, followed by financial shocks, marginal efficiency of investments and – with smallest shares – investment-specific technology news and fiscal policy.

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Figures and Tables

Table 1: Pairwise correlation of estimated US shocks

	Tech.	Fin.	IST	MEI	MP	FP
Tech.	1.00					
Fin.	0.08	1.00				
IST	0.03	-0.16	1.00			
MEI	0.25	0.02	-0.31	1.00		
MP	0.27	0.10	0.06	0.11	1.00	
FP	0.04	0.21	0.10	-0.12	-0.17	1.00

Note: Shock abbreviations refer to: Tech. - Maximum share technology shock as in Francis et al. (2014), Fin. - financial shock as in Gilchrist and Zakrajšek (2012), IST - investment-specific technology as in Ben Zeev and Khan (2015), MEI - marginal efficiency of investment as in Justiniano et al. (2011), MP - monetary policy as in Nakamura and Steinsson (2018), FP - fiscal policy news shock as in Forni and Gambetti (2016). Dataset spans the period 1995q2-2019q4.

Table 2: Total contribution of US shocks in the forecast error variance decomposition (in percent).

	Panel			**US**
Horizon	baseline	US controls	core controls	
0	3.1 (1.3)	3.3 (1.4)	3.4 (1.4)	35.6 (3.4)
4	20.0 (4.5)	18.0 (4.7)	16.3 (4.3)	65.3 (3.6)
8	26.5 (5.9)	24.7 (6.0)	20.3 (5.6)	71.2 (3.9)
12	30.6 (7.5)	28.7 (7.1)	23.3 (6.6)	73.8 (4.2)
16	33.2 (8.2)	32.4 (8.0)	26.9 (7.7)	74.5 (4.7)
20	37.1 (9.3)	36.3 (8.8)	30.9 (8.5)	77.1 (4.7)

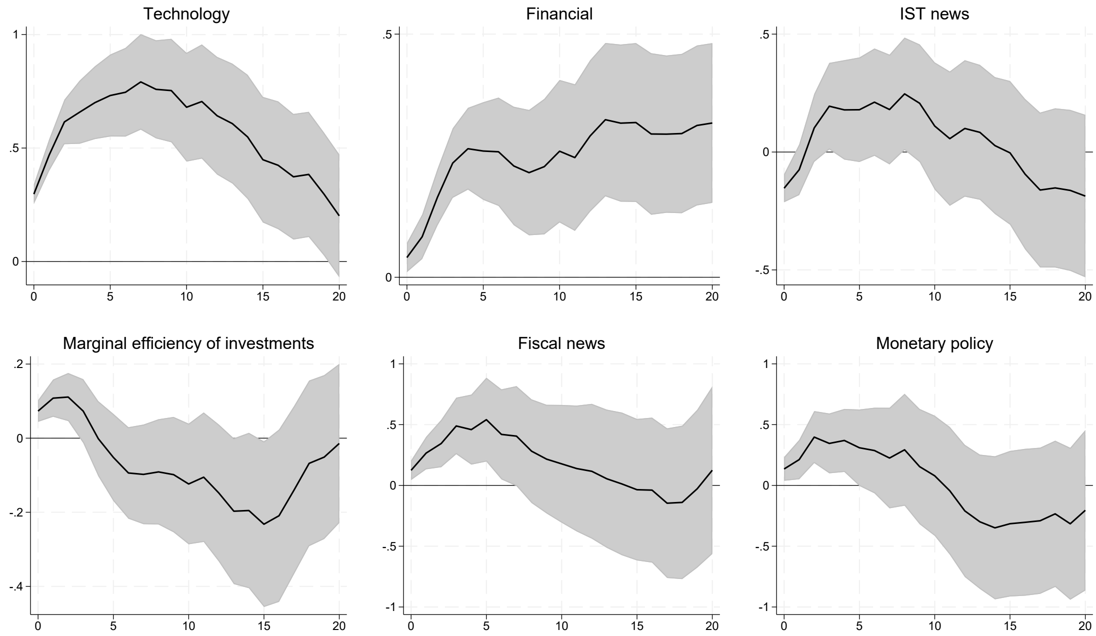
Note: Reported values represent average contributions and their standard deviations (in brackets) from 600 bootstrap estimations, each based on 1,000 simulated observations.

Table 3: Share of individual shocks in FEVD of output in open economies (in percent).

Horizon	Tech.	Fin.	IST	MEI	MP	FP
0	1.7 (0.9)	0.3 (0.4)	0.6 (0.5)	1.4 (1.0)	0.7 (0.6)	0.3 (0.4)
4	9.6 (3.3)	5.5 (2.5)	1.8 (1.5)	5.4 (3.1)	8.1 (3.1)	0.6 (0.5)
8	13.1 (5.0)	7.9 (4.0)	1.9 (1.7)	5.8 (3.8)	12.6 (4.9)	1.5 (1.4)
12	14.0 (7.0)	8.2 (5.1)	2.2 (1.9)	5.6 (4.1)	15.5 (6.6)	1.9 (1.7)
16	14.7 (7.0)	9.2 (5.4)	2.5 (2.2)	5.4 (4.5)	16.3 (7.7)	2.8 (2.5)
20	16.1 (8.0)	9.4 (6.2)	2.8 (2.6)	5.1 (4.1)	17.2 (9.0)	3.8 (3.3)

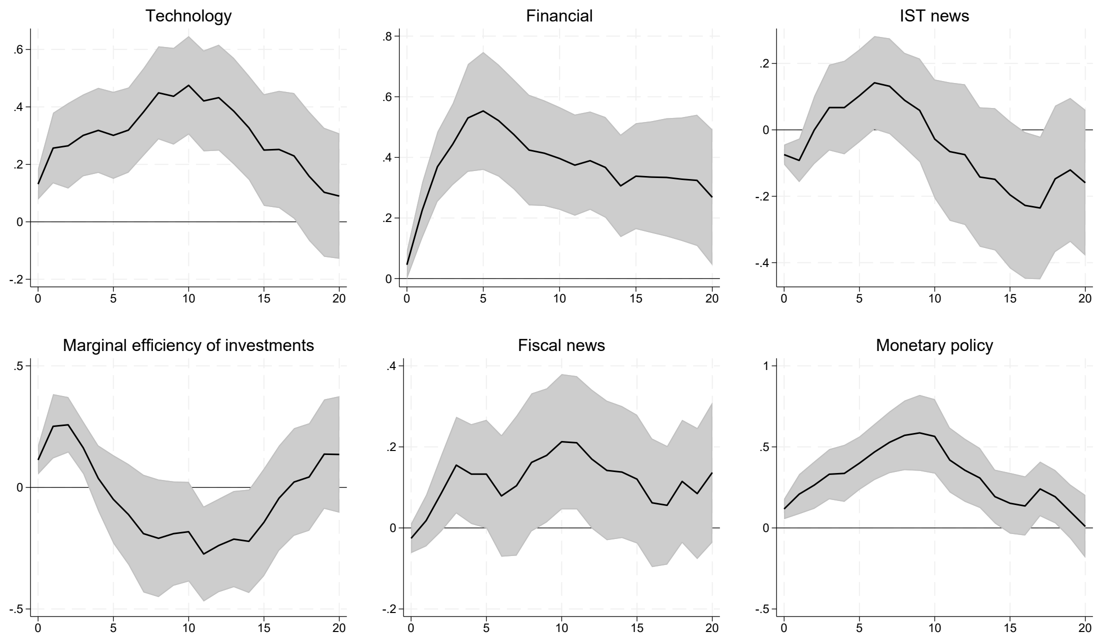
Note: Reported values represent average contributions and their standard deviations (in brackets) from 600 bootstrap estimations, each based on 1,000 simulated observations. The sum of estimated contributions of individual shocks from shock-specific estimations may be different from the the estimated total contribution presented in Table 2 due to various length of samples when estimating individual shocks contributions (see section 2.4 for more details) and because of differences in econometric model specification as explained in Section 2.2. Shock abbreviations refer to: Tech. - Maximum share technology shock as in Francis et al. (2014), Fin. - financial shock as in Gilchrist and Zakrajšek (2012), IST - investment-specific technology as in Ben Zeev and Khan (2015), MEI - marginal efficiency of investment as in Justiniano et al. (2011), MP - monetary policy as in Nakamura and Steinsson (2018), FP - fiscal policy news shock as in Forni and Gambetti (2016).

Figure 1: Impulse responses of US GDP to US shocks



Note: The shaded area depicts 68% confidence bands.

Figure 2: Impulse responses of GDP in other countries to US shocks



Note: The shaded area depicts 68% Discroll-Kraay confidence bands.

Appendix: Data sources

Table 1: Data used for estimation of technology shock based on Francis et al. (2014).

Description	Source
Real gross domestic product, billions of chained 2012 dollars, seasonally adjusted annual rate	Federal Reserve Bank of St. Louis
Personal consumption expenditures, billions of dollars, seasonally adjusted annual rate	Federal Reserve Bank of St. Louis
Employment level, thousands of persons, seasonally adjusted	Federal Reserve Bank of St. Louis
Gross private domestic investment, billions of dollars, seasonally adjusted annual rate	Federal Reserve Bank of St. Louis
Quarterly hours worked and employment in total U.S. economy and subsectors (nonfarm business: total)	U.S. Bureau of Labor Statistics

Note: scope of reproduction 1948q2 - 2022q3.

Table 2: Data used for estimation of financial shock based on Gilchrist and Zakrajšek (2012).

Description	Source
Real personal consumption expenditures, billions of chained 2017 dollars, seasonally adjusted annual rate	Federal Reserve Bank of St. Louis
Federal funds effective rate, percent, not seasonally adjusted	Federal Reserve Bank of St. Louis
Real gross domestic product, billions of chained 2017 dollars, seasonally adjusted annual rate	Federal Reserve Bank of St. Louis
Implicit price deflator index (2017=100)	Federal Reserve Bank of St. Louis
Real gross private domestic investment, billions of chained 2017 dollars, seasonally adjusted annual rate	Federal Reserve Bank of St. Louis
Market yield on U.S. Treasury securities at 10-Year constant maturity, quoted on an investment basis	Federal Reserve Bank of St. Louis
Excess bond premium	Catalán and Hoffmaister (2023)
Excess stock market return, based on annualized change of SNP500 net of 3-month (end of quarter) rates	Bloomberg

Note: scope of reproduction 1973q1 - 2023q2.

Table 3: Data used for estimation of investment-specific news shock from Ben Zeev and Khan (2015).

Description	Source
Investment-specific technology (IST), computed as a ratio between two deflators: consumption and investment (CONSDEF / INVDEF)	Federal Reserve Bank of St. Louis
Utilization-adjusted quarterly TFP series for the U.S. business sector	Fernald (2014)
Gross domestic product, billions of dollars, seasonally adjusted annual rate	Federal Reserve Bank of St. Louis
Domestic consumption (FRED series: $PCEC - PCDG$)	Federal Reserve Bank of St. Louis
Domestic investment (FRED series: $GPDI + PCDG$)	Federal Reserve Bank of St. Louis
Hours worked and employment in total U.S. economy and subsectors (nonfarm business: total)	U.S. Bureau of Labor Statistics
Consumer price index for all urban consumers: all items in U.S. city average, percent change, seasonally adjusted	Federal Reserve Bank of St. Louis
Credit spread index, computed as a difference between MOODCAAA and MOODCBAA	Bloomberg
3-Month Treasury bill secondary market rate, discount basis, percent, not seasonally adjusted	Federal Reserve Bank of St. Louis

Note: scope of reproduction 1951q1 - 2022q2.

Table 4: Local-projection data sources.

Description	Source
GDP (expenditure approach): National currency, volume estimates, OECD reference year, annual levels, seasonally adjusted	OECD
CPI: all items, Percentage change on the same period of the previous year	OECD
Short-term interest rates	OECD
Exchange rate against the US dollar	OECD
VXO index	FRED / Piffer and Podstawski (2017)

Table 5: Time span of data for local projections.

Country	Data span
United States	1970q1-2019q4
Australia	1995q2-2019q4
Canada	1995q2-2019q4
Israel	1995q2-2019q4
Korea	1995q2-2019q4
New Zealand	1995q2-2019q4
Norway	1995q2-2019q4
Sweden	1995q2-2019q4
France	1995q2-2019q4
Germany	1995q2-2019q4
Japan	2002q2-2019q4
United Kingdom	1995q2-2019q4
Chile	1997q3-2019q4
Colombia	1995q2-2019q4
Czechia	1995q2-2019q4
Hungary	1995q2-2019q4
Mexico	1997q1-2019q4
Poland	1995q2-2019q4
Turkey	1999q3-2019q4
India	2012q1-2019q4
Indonesia	2000q1-2019q4
Brazil	2000q1-2019q4

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